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Effect of water and organic nutrient management on productivity of *kharif* rice

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ABSTRACT

The field experiment was undertaken during kharif seasons of 2010 and 2011 to evaluate water and organic nutrient management options for higher productivity of kharif rice and residual soil fertility in a sandy loam soil of organic block of central research farm, OUAT, Bhubaneswar with pH 6.2; OC 6.5g kg^{-1} soil; available N, P and K, 190, 30.2 and 165.3 kg ha^{-1}, respectively. The experiment was laid out in a split plot design with three replications. The main plot was allotted with four water management treatments and the sub plot had four organic nutrient management treatments. Irrigation at 5 days after disappearance of ponded water (ADP), I_3 to rice crop expressed its superiority as regards to plant character, yield attributes, yield and economics. Similarly, dhanicha @ 25 kg seed ha^{-1} + FYM @ 2t ha^{-1} at 21 DAP + vermicompost @ 2t ha^{-1} (basal) (N_4) was found better for all yield attributing characters among organic nutrient management options(ONM) but was at par with dhanicha + FYM @5t ha^{-1} at 21 DAP (N_3) and dhanicha +FYM @ 5t ha^{-1} (basal) (N_2). After application of ONM, soil nitrogen and phosphorous showed a negative balance where as soil potassium had positive balance. Available nutrients increased from the initial values irrespective of water and organic nutrient management options in this experiment.

Keywords**:** ONM, productivity, rice, soil health, water management

Rice feeds about 50 per cent of the world population provide 19 per cent of the global calorie intake (IRRI, 2014). In India, during 2012-13, rice was grown in an area of 42.7 million hectare area with a production of 105.3 million tones. With the burgeoning population of the country, the demand for rice is ever increasing and it is estimated that by 2025 AD, the requirement would be about 135 to 140 mt. To sustain the present self sufficiency in food grain production and to fulfill the target of future food requirement, India has to increase its rice productivity by 3 per cent per annum (Thiyagarajan, and Selvaraju, 2001). The goal of sustainable agriculture is to maintain production at levels necessary to meet the increasing aspiration of expanding world population without degrading the environment. Organic agriculture is one of the broad spectrum production methods that support the environment. It has at its root, the twin objective of the system being sustainable and environmentally benign. Comparing conventional and organic farms, showed that the later tend to have higher soil organic matter content and lower nutrient losses (Tuomisto *et al.*, 2012). The concept of soil as a living system that develops the activities of beneficial organisms is central to organic agriculture (Chhonkar, 2001). Organic nutrition, which is responsible for material circulation in agricultural ecosystem and augments crop production with minimal environmental load, aims at holistic approach for production and management system enhancing health of agricultural ecosystem (Otto, 2003). Unlike chemical farming, organic farming aims at feeding the soil rather than 'feeding the plant'. The appropriatness of soil to sustain flora mostly depend on its physical properties (porosity, WHC, structure and tilth) and chemical properties (nutrient supply capacity and pH) which are directly linked with soil organic matter (Doran and Safley, 1997).Soil organic matter serves as nutrient and energy source for a diverse population of soil bacteria, fungi and invertebrates such as earth worms (Leroy, 2008).

In Asia irrigated agriculture accounts for 90% of the total diverted fresh water and more than 50% of this is used to irrigate rice. However availability of water for agriculture is declining steadily due to urbanization and rapid increase in population (Xue *et al.*,2008). Increasing scarcity of water threatens the sustainability of irrigated rice production system and hence , food security and livelihood of rice producers and consumers. Therefore, rice intensification with less water availability has become imperative at this crucial juncture of water scarcity. Considering these aspects, this research work on response of organically grown *kharif* rice to nutrient and water management options was initiated.

MATERIALS AND METHODS

The field experiment was conducted during the *kharif* season of 2010 and 2011 in the organic block of Agronomy Main Research Farm, OUAT, Bhubaneswar. The latitude and longitude of the research station are $20^0$15'N and $85^0$52'E, respectively, with an altitude of 25.9m above mean sea level. The soil of the experimental site was sandy loam in texture with pH, 6.2 ; OC , 6.5g kg^{-1} soil ; available N,P and K

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190, 30.2 and 165.3 kg ha^{-1}, respectively. The experiment was laid out in a split plot design with three replications. The main plot had four water management treatments, *viz.* rainfed (I_1), 7 days after disappearance of ponded water (ADP) (I_2), 5 days ADP (I_3) and 3 days ADP (I_4) and the subplots had four organic nutrient management treatments , *viz*. dhanicha (*Sesbania aculeata*) @ 25 kg seed ha^{-1} (N_1), dhanicha + FYM @5 t ha^{-1} as basal (N_2), dhanicha + FYM @5t ha^{-1} at 21 DAT (N_3) and dhanicha +vermicompost @ 2t ha^{-1} as basal + FYM@ 2t ha^{-1} at 21 DAT(N_4). Rice cv. 'Lalata' was grown in both the years.

Table 1: N, P and K content of various sources of organic nutrients

Material	Content (%)		
	N	P	K
FYM	0.53	0.17	0.23
Dhanicha (Fresh)	0.59	0.10	0.21
Vermicompost	1.56	0.53	0.62

Soil available N was estimated by modified Kjeldahl method, P by Olsen's method and K by flame photometer method (Jackson, 1973). Balance sheet of nutrients is estimated by using the formula: B= (U+F) – (I+A); where, B is balance of nutrient in soil (kg ha^{-1}), U is uptake of particular nutrient by crop (kg ha^{-1}), F is final soil status (kg ha^{-1}), I is initial soil status (kg ha^{-1}) and A is nutrient added to soil (kg ha^{-1}). Data obtained of two years experimentation were pooled and statistically analysed using F test as per the procedure given by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Biometrics, yield attributes and yield

The biometric observations, yield attributes and yield of rice were significantly influenced by water and organic nutrient management options (Table 2). The plant height of rice at harvest was the highest (122.3cm) due to irrigation at 5 days ADP (I_3) and was at par with that of treatment irrigation at 3 days ADP (I_4). Similarly, ONM treatment dhanicha + FYM @ 2t ha^{-1} at 21 DAT + vermicompost @ 2t ha^{-1} as basal (N_4) registered the highest plant height of 121.6 cm which was *at par* with those of treatments dhanicha + FYM @ 5t ha^{-1} at 21 DAT and dhanicha +FYM @ 5t ha^{-1} (basal). Tiller count m^{-2} was the maximum for I_3 (331.9) and was *at par* with I_4 among water management treatments and for N_4 (345.7) and *at par* with N_3 among nutrient management treatments. Ear bearing tiller m^{-2} of rice was also maximum for I_3 and N_4 treatments. Number of grains panicle^{-1} was significantly the maximum for I_3 (121.7)

Table 2: Effect of water and ONM on biometrics, yield attributes and yield of *kharif* rice (pooled)

Treatment	Final plant height (cm)	Maximum tiller m^{-2}	Ear bearing tiller m^{-2}	Conversion (%)	Grains per panicle	Test weight (g)	Grain yield (kg ha^{-1})	Straw yield ha^{-1}	Net return (Rs. ha^{-1})	Return rupee^{-1} invested (Rs.)
Main plot: water management										
I_1 Rainfed	115.1	271.6	212.1	78.1	109.5	25.9	4620	5046	23832	1.92
I_2 Irrigation at 7 days ADP	117.0	297.0	235.5	79.3	113.9	26.7	4645	5031	23912	1.92
I_3 Irrigation at 5 days ADP	122.3	331.9	268.8	81.0	121.7	27.0	5382	5654	31258	2.17
I_4 Irrigation at 3 days ADP	120.1	326.0	256.6	78.7	118.1	26.7	5209	5556	28979	2.07
SEm (±)	**0.78**	**11.21**	**9.74**		**0.69**	**0.21**	**107.1**	**112.9**		
LSD (0.05)	**2.72**	**33.67**	**33.72**		**2.39**	**0.73**	**370.6**	**390.8**		
Sub plot –ONM										
N_1 Dhanicha@25kg seed ha^{-1}	113.3	258.5	190.5	73.7	102.9	25.0	4036	4412	18568	1.75
N_2 Dhanicha + FYM @5t ha^{-1} (Basal)	118.7	296.8	243.4	82.0	116.1	26.8	5199	5612	29688	2.13
N_3 Dhanicha+FYM @5t ha^{-1} at 21 DAT	120.9	323.7	263.2	81.3	120.2	27.2	5205	5532	29692	2.13
N_4 Dhanicha + FYM @2t ha^{-1} at 21 DAT + vermicompost @2t ha^{-1} (basal)	121.6	345.7	275.9	79.8	124.0	27.3	5414	5731	30978	2.14
SEm (±)	**1.61**	**7.88**	**5.94**		**1.17**	**0.14**	**74.2**	**94.3**		
LSD (0.05)	**4.69**	**23.01**	**17.33**		**3.41**	**0.56**	**216.7**	**275.3**		

and N_4 (124.0) treatments. The 1000 grain weight of rice varied between 25.9 to 27.0g for water management treatments and between 25.0 to 27.3g for ONM treatments.

Grain yield of rice was registered the highest for I_3 treatment (5382 kg ha^{-1}) and was *at par* with I_4 treatment (5209 kg ha^{-1}). Similarly, within organic nutrient management treatments, N_4 registered the highest grain yield (5414 kg ha^{-1}) and was *at par* withN_2 and N_3. Straw yield followed similar trend.

The interaction effect of water and organic nutrient management on grain yield of rice was significant (Table 3). Maximum grain yield (6324 kg ha^{-1}) was obtained when the crop was irrigated 3 days ADP and supplied with N_4. However, this was *at par* with irrigation at 5 days ADP under same nutrient application. Irrigation at different days after disappearance of ponded water provided variable environment condition with respect to available soil water and soil aeration. Uninterrupted and smooth availability of soil water facilitates the plants to take up more nutrients from soil and aeration in root zone kept the roots active and vigorous. Root volume of rice increased due to aeration which reached out to the nutrients for their uptake and further metabolism. Both the conditions soil air and soil water if combined (together), the treatment irrigation at 5 days ADP (I_3) expressed its superiority over other treatments. Application of FYM improves soil physical conditions, especially, the structure, water holding capacity, bulk density, porosity *etc.*, chemical conditions such as pH, EC and available nutrients and apart from these, the microbial enzymatic activities are enhanced that encourage root development and growth of crop (Shekara *et al*., 2010). Green manures contain two fractions of which, one undergoes faster decomposition and release of nutrients for current crop, while other goes at slower rate. Enhanced organic carbon has been attributed to the later fraction (Deshpande and Devasenapathy, 2010). Vennila *et al*. (2007) also reported significant increase in growth due to continuous and slow release of nutrient supply from green manuring during most of the rice growing season.

Balance of soil nitrogen and phosphorous showed negative values due to water and organic nutrient management options (Table 4). However, the magnitude of these values were quite less and negligible in the context of rice crop. On the other hand, balance of soil potassium exhibited positive values due to water and organic nutrient management practices. But, availability of nutrients in soil increased irrespective of water and nutrient management treatments. Legumes (*Sesbania aculeata)* grown in rotation with low land rice can scavenge soil mineral N which might otherwise be lost by denitrification or leaching after soil is flooded for rice production (Singh, 1984). Higher available N content of soil under FYM addition could be due to favourable microbial activity and enhanced biomass addition to the soil. Vennila *et al*. (2007) reported that available N and P of soil after the crop harvest increased considerably as compared to the initial level due to FYM application. Singh *et al.* (2008) observed that highest available P was recorded with application of vermicompost followed by FYM, green manuring and residue incorporation. The increased available P content of soil might be due to release of CO_2 and organic acids during decomposition, which helps in solubilizing the native soil P. The organic matter (humus) may also reduce the fixation of phosphate by providing protective cover on sesquioxides and chelating cations like Ca^{+2} and Mg^{+2}, which in turn enhanced availability of P. They further opined that the beneficial effect of FYM, vermicompost, green manuring on available K may be ascribed to the reduction of K-fixation, solubilization and release of K due to the interaction of organic matter with clay.

Table 3: Interaction effect of water and organic nutrient management on grain yield (kg ha^{-1}) of rice

Treatment	N_1	N_2	N_3	N_4	Mean
I_1	2814	5742	5152	4773	4620
I_2	4240	5149	4725	4459	4645
I_3	4607	5030	5789	6101	5382
I_4	4480	4877	5152	6324	5209
Mean	**4036**	**5199**	**5205**	**5414**	
	I x N	N x I			
SEm (±)	**167.4**	**148.5**			
LSD (0.05)	**525.6**	**433.3**			

Economics

The net return and return per rupee invested were influenced by water and organic nutrient management treatments (Table 5).The maximum net return and return per rupee invested were received from application of irrigation at 5 days ADP (Rs 31,258.00 ha^{-1} and Rs. 2.17, respectively). This was closely followed by those of irrigation at 3 days ADP. The net return and return per rupee invested gradually increased from N_1 to N_4 being the maximum for N_4 (Rs. 30,978.00 ha^{-1} and Rs. 2.14, respectively). However, these were close to those of treatments N_3 and N_2.

Table 4: Effect of water and organic nutrient management on soil nutrient balance (Mean)

	Nitrogen (kg ha^{-1})				Phosphorous (kg ha^{-1})				Potassium (kg ha^{-1})			
Initial	190.0				30.2				165.3			
Treatment	**Added**	**Removed**	**Available**	**Balance**	**Added**	**Removed**	**Available**	**Balance**	**Added**	**Removed**	**Available**	**Balance**
I_1	133.7	83.8	220.0	-19.9	26.4	17.53	30.3	-8.77	49.1	106.47	174.2	66.27
I_2	133.7	83.5	217.0	-23.2	26.4	17.23	30.5	-8.87	49.1	107.83	175.3	68.73
I_3	133.7	91.4	214.0	-18.3	26.4	18.31	30.8	-7.49	49.1	115.89	176.8	78.29
I_4	133.7	91.0	214.0	-18.7	26.4	17.88	30.8	-7.92	49.1	115.08	176.2	76.88
N_1	109.7	73.7	212.0	-14.0	18.6	15.35	30.3	-3.15	39.1	95.03	174.6	65.23
N_2	136.2	91.8	215.0	-19.4	27.1	18.26	30.6	-8.44	50.6	115.46	175.6	75.16
N_3	136.2	92.6	216.0	-17.6	27.1	18.31	30.6	-8.39	50.6	116.40	175.9	76.40
N_4	152.7	94.0	218.0	-30.7	32.6	18.45	30.8	-13.55	56.1	117.86	176.3	72.76

It is revealed that interaction of irrigation at 3 days ADP and dhanicha 25 kg ha^{-1} + vermicompost @ 2t ha^{-1} (basal) +FYM @2t ha^{-1} (21 DAT) produced the maximum grain yield which was *at par* with that of irrigation at 5 days ADP under same organic nutrient management treatments. However, keeping the economics of production in view, irrigation at 5 days ADP and dhanicha 25kg seed ha^{-1} + vermicompost @ 2t ha^{-1} (basal)+ FYM @ 2t ha^{-1} (21 DAT) was found to be the best treatment for adoption.

REFERENCES

Chhonkar, P.K. 2001.The state of Indian soil science and challenges to be faced during twenty first century. *J. Indian Soc. Soil Sci.,***49**:532-36.

Deshpande, H. and Devasenapathy, P. 2010. Influence of green manure and different organic sources of nutrients on yield and soil chemical properties of rice grown under low land condition. *Int. J. Agril. Sci.,* **6**: 433-38.

Doran, J.W. and Safley, M.1997. Defining and assessing soil health and sustainable productivity. In: *Biological Indicators of Soil Health* (Eds.), CAB International : New York, pp. 28.

Gomez, K.A. and Gomez, A.A. 1984. *Statistical Procedures for Agricultural Research.* A Willey Inter Science Publication, New York, pp. 76-83.

IRRI. 2014. *World Rice Statistics.* Online query facility web page http://rice stat.irri.org: 8080/wrs2/entry point.html (accessed on 21.04.14).

Jackson, M.L. 1973. *Soil Chemical Analysis*. Prentice Hall of India Private Ltd., New Delhi, pp. 498.

Leroy, B.L.M., Herath, H.M.S.K., Sleutel, S., De Neve, S., Gabriels, D., Reheul, D. and Moens, M. 2008. The quality of exogenous organic matter: short term effects on soil physical properties and soil organic matter fractions. *Soil Use Managt.*, **24**:139-47.

Otto. 2003. Codex Elimentarius In: *The World of Organic Agriculture. Statistics and Future Prospects* (Eds. Minon Yussefi and Helga Willer), pp.41-44.

Shekara, B.G., Sharanappa and Krishnamuthy, N. 2010. Effect of irrigation schedules on growth and yield of aerobic rice under varied levels of FYM in Cauvery command area. *Indian J. Agron.,* **55**: 35-39.

Singh, N.T. 1984. *Organic Matter in Rice*. (Pub) IRRI, Los Banos, Philippines, pp. 217-28.

Singh, F., Kumar, R. and Pal, S. 2008. Integrated nutrient management in rice wheat cropping system for sustainable productivity. *J. Indian Soc. Soil Sci.,* **56** : 205-08.

Thiyagarajan, T.M. and Selvaraju, R. 2001. Water saving in rice cultivation in India. In: *Proc. Int. Workshop on Water Saving Rice Production Systems.* April 2-4, 2001. pp. 15-41.

Tuomisto, H.L.,Hodge, I.D., Riordon, P. and MacDonald, D.W. 2012. Does organic farming reduce environmental impacts?-a meta analysis of European research. *J. Env. Managt.,***112**:309-20.

Vennila, C., Jayanthi, C. and Nalini, K. 2007. Nitrogen management in wet seeded rice –A review. *Agri. Rev.,* **28** : 270-76.

Xue, C. Yang, X., Bouman, B.A.M., Deng , W., Zhang, Q., Yan, W., Zhang, Q., Yan, W., Zhang, T., Rouzi, A. and Wang, H. 2008. Optimizing yield, water requirements, and water productivity of aerobic rice for the north China plain. *Irrig. Sci.,* **26**: 459-74.